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Motorized Driving Safety System Using Eye Detection Analysis Method

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Abstract: Traffic accident, particularly two-wheeled vehicles, is a problem for the Government, especially the Resort Police Traffic Unit (*Satlantas Polres*). The factor that causes the traffic accident incident is divided into three types, namely human factor, vehicle factor, and road or environment factor. The human factor is the most common factor for an accident. Fatigue factor that causes someone to feel sleepy while driving often results in a traffic accident. Based on the problem, the researcher wanted to create a technology innovation of a motorized driving safety system in the form of a helmet. The researcher made an innovation of a helmet that can detect drowsiness through the driver's eye blink duration. The drowsiness will be detected by using a camera sensor. The camera sensor used was Open MV camera. The method used in detecting sleepy drivers was the eye detection analysis method. The method enable detection based on the data of the duration of eye condition when it is closed and open. The closed eye has a low RBG mean value of 110-113 and an RBG median value of 99-109. Whereas opened eye has a higher RGB mean value of 179-206 and RGB median value of 178-206. The result of the research showed that someone's sleepy condition occurred when closing their eyes for more than 0.4 seconds to 4 seconds. The helmet is also equipped with GPS to monitor the position in the event of an accident as an emergency response effort.

Keywords: Eye detection; Helmet; Safety; Traffic accident

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Introduction

Traffic accidents, especially two-wheeled vehicles, are a problem for the Government, especially the Resort Police Traffic Unit (Satlantas Polres). The data from The Jember Police Traffic Unit (Satlantas Polres) from 2017 to 2019 shows that there were 3,543 cases of traffic accidents. Traffic data recorded 1146 accidents in Jember Regency at the end of 2019 (Gempur, 2020). Several factors influence the increase in the number of traffic accidents. These factors are classified into three types: human factors, vehicle factors, and road and environmental factors (Puspita, 2020). Human, as one of the factors, tends to ignore safety. For example, motorcycle riders do not realize that they feel sleepy, and they often force themselves to keep riding (Puspita, 2009). The types of vehicles that are often involved in accidents every year are motorcycle-type vehicles, with 5,095 accidents (Puspita, 2020).

One of the ways to overcome the problem of drowsiness is to apply sensor technology innovation. The researchers made a technological innovation in the form of a helmet that can detect fatigue or drowsiness in riders. Fatigue or drowsiness will be detected using image processing (Chaidir, 2018). The method used to detect and identify the drowsiness of two-wheeled motorists is eye detection analysis (Hartiansyah, 2019). Blink detection is used to determine the duration of closed eyes (Haq, 2026). The researchers add a vibrating

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system to the rider's helmet if the rider is detected to be sleepy (Hadi, 2022). The helmet is also equipped with GPS for position monitoring in an accident. The GPS module can be used to determine the position based on the latitude and longitude coordinates on the google map (Yudhana, 2019). The information about the position will be sent via mobile phone message to relatives, police stations, and hospitals in the event of an accident. This emergency response effort is carried out quickly to help accident victims who use the helmets.

Method

Technological innovation in the form of a helmet could detect fatigue or drowsiness in the rider. The helmet technology design is shown in Figure 1. Fatigue or drowsiness would be detected using a camera sensor (Chaidir, 2020). The camera sensor was placed in front of the vehicle user's helmet. The camera sensor would detect the condition of the eyes being closed and open (Rahardi, 2021). The camera sensor would give a signal when the eye is detected in a state of fatigue or closed for 4 seconds.

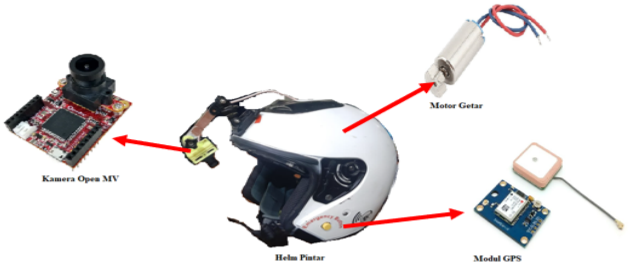


Figure 1. Helmet Device Design

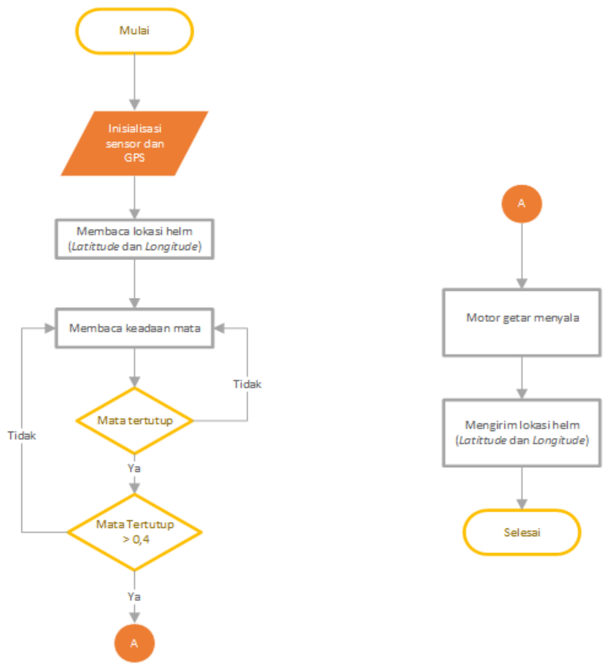


Figure 2. Helmet Algorithm Design

Furthermore, the signal in the form of an analog signal would be converted into a digital command by the Arduino microcontroller. Digital data from the microcontroller became a command to move the vibrating motor in the helmet to wake the rider.

Figure 3. Conditions When Detecting Closed Eyes

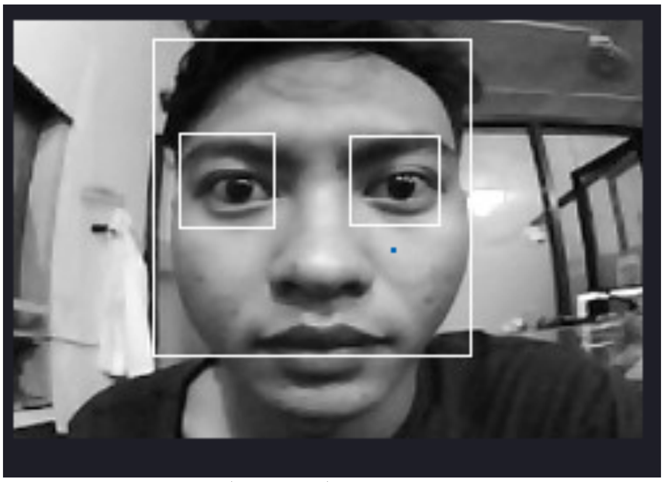


Figure 4. Conditions When Detecting Eyes Open

An additional safety system in the form of GPS was also installed on the helmet. The GPS was used to provide position information to the mobile phone registered by the driver. Riders could activate the GPS by pressing the button on the helmet. The operational flow is represented in Figure 2. The input device of this system was an OpenMV camera. The Open MV camera took a facial image and then detected the eye part of the motorist (Robin, 2020). Figure 3 is a driver's face detection. Furthermore, using the python programming library, the facial image taken was detected only in the eye area shown in Figure 4. The eye-detection analysis method was used to detect open and closed eye conditions based on the resulting parameters (Tanmay et al., 2019). Some parameters could be used to distinguish between open and closed eye conditions. These parameters included histogram of RGB color readings from eye images consisting of mean RGB, Median RGB, StdDev RGB, LQ and UQ (Xu and Lin, 2017). The comparison of histogram images when the eyes were open and closed is shown in Figure 5 and Figure 6.

Figure 5. RGB histogram when eyes are open

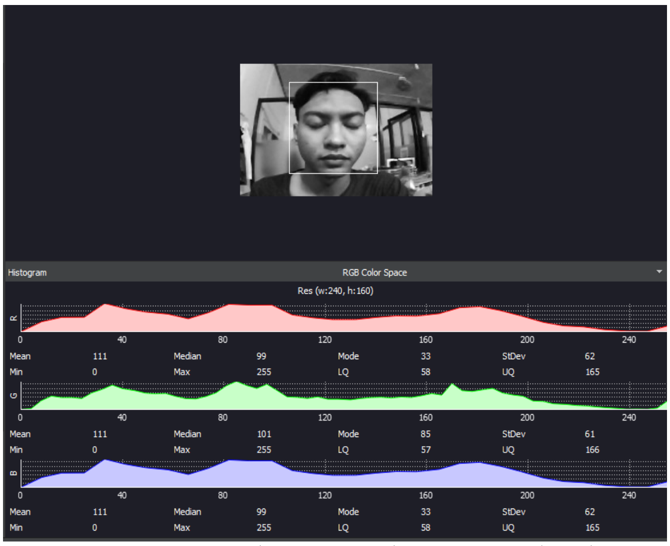


Figure 6. RGB histogram when eyes are closed

The RGB histrogram image data generated by the open MV camera had significant differences in the RGB mean parameters and the RGB median when the eyes are closed and open. This parameter is used to detect the condition of closed and open eyes.

Once the system can detect the condition of closed and open eyes, it further distinguishes the condition when the eyes are closed due to regular blinking or drowsiness. To find out the level of drowsiness of the rider, eye tracking is carried out including the frequency of the duration of the eye blinking. The camera will detect the frequency and duration of the closed eyes. The result of the camera capture will later send a signal for the motor vibration to vibrate the helmet. Open or closed eyes detection retrieval is categorized into three categories, closed eyes that will first be categorized as blinking and time is run in seconds. The second closed eye with **a less** time of 0.4 seconds is then categorized as closed eye. For the third closed eye in more than 0.4 seconds and less than 4 seconds then, it is categorized as drowsy eyes. However, if there is an open eye result, the time will be restarted after there is a description of the further closed eye detection results.

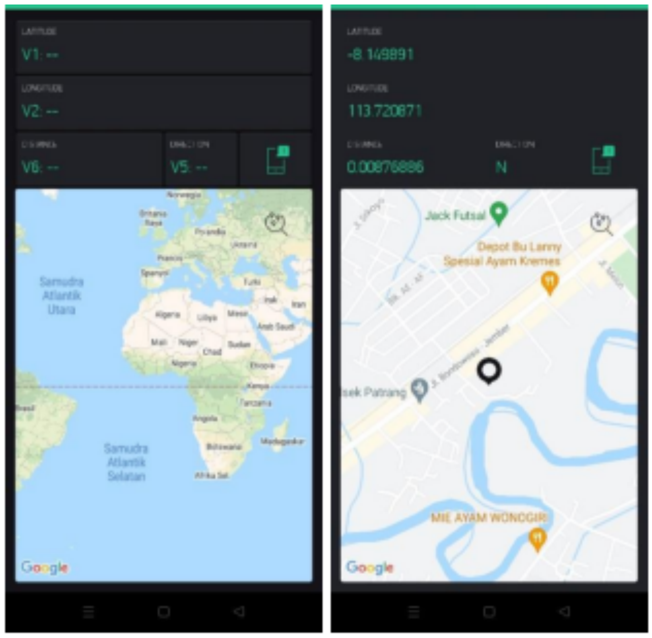


Figure 7. Displays of Position Information on Handphone

The helmet is also equipped with an emergency response system in the event of an unwanted accident in a rider. This system is in the form of the position of the driver which is detected through GPS. The GPS used is the ublox neo-6m GPS module that can send position information to the cellphone that has been registered by the rider. Figure 7 is a display of the position information that the helmet displays to the recipient of the message.

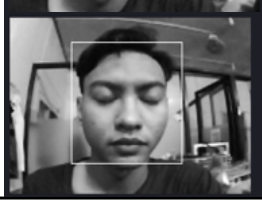
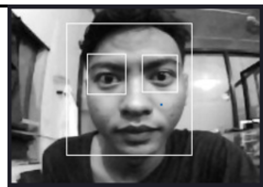
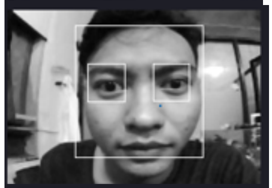
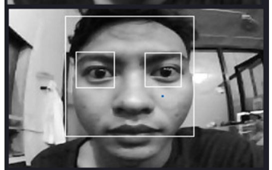
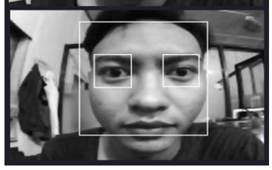
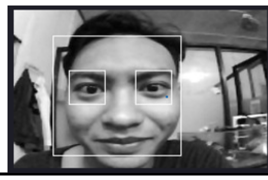
Result and Discussion

Detection of Eye Fatigue (Drowsiness)

Detection of eye fatigue is carried out in two stages; the first is the detection of open and closed eyes. The device used to detect open and closed eyes is an OpenMV camera. The Open MV camera is used to capture images of a rider. Table 1 is the data from the trial carried out as many as 10 times of the test consisting of 5 times the condition of closed eyes and 5 times the condition of open eyes. There are two parameters to detect the condition of open and closed eyes based on the histrogram generated by the Open MV camera, namely the RGB mean and the RGB median. The results of RGB and median RGB mean parameters have significant differences, for example in Table 1 number 1 has a mean for R of 113, G of 113 and R of 112 in a closed eye condition. Meanwhile, when the eye is open, it is shown that number 6 has a higher mean for R of 189, G of 190 and B of 189. Likewise, the RGB median parameter value, for example number 1 has a median R of 107, a G of 109, and a B of 107 when the eye is closed. Meanwhile, when the eye condition is open, exemplified at number 6, it produces a median R of 189, a G of 190, and a B of 189. Based on the results of the data in Table 1, it can be concluded that the closed eye condition has a low RBG mean value, which is about 110 to 113 and the RGB median value is about 99 to 109. As for the open eye condition, it has a higher value, namely for the RGB mean value is about 179 to 206 and the RGB median value in 178 to 206. The values of these two parameters are set points to distinguish the condition of closed and closed eyes.

Detection of the rider's drowsiness condition by eye tracking includes the frequency of the duration of the blink of an eye. Camera testing was performed by taking 20 different types of image samples, each of which was an image from open to closed eyes. Each closed eye differs from duration of 0.1 seconds to 4 seconds. Then the accuracy level of the calculation will be determined from whether the eyes are detected closed or not. From this calculation, it can be known whether the system can find out the level of fatigue of a rider.

Tabel 1. Detection of Open and Close Eyes

No	Color	Mean	Median	Gambar
1	R	113	107	
	G	113	109	
	B	113	107	
2	R	112	99	
	G	112	101	
	B	112	99	
3	R	113	99	
	G	112	101	
	B	113	99	
4	R	110	107	
	G	110	101	
	B	110	107	
5	R	111	99	
	G	111	101	
	B	111	99	
6	R	189	189	
	G	190	190	
	B	189	189	
7	R	181	181	
	G	179	178	
	B	181	181	
8	R	206	206	
	G	206	206	
	B	206	206	
9	R	185	188	
	G	184	182	
	B	185	181	
10	R	182	186	
	G	182	180	
	B	184	183	

Tabel 2. Length of Closing Eyes Detection

No	Length of closing eye (Second)	Category
1	0.1	Ordinary Blink
2	0.2	Not drowsy
3	0.3	Not drowsy
4	0.4	Not drowsy
5	0.5	Drowsy
6	0.6	drowsy
7	0.7	drowsy
8	0.8	Drowsy
9	0.9	Drowsy
10	1.0	Drowsy
11	1.1	Drowsy
12	1.2	Drowsy
13	1.3	Drowsy
14	1.4	Drowsy
15	1.5	Drowsy
16	2.0	Drowsy
17	2.5	Drowsy
18	3.0	Drowsy
19	3.5	Drowsy
20	4.0	Drowsy

Open or closed eye detection retrieval is categorized into three categories, closed eyes that will first be categorized as blinking and time is run in seconds. The second closed eye with a less time of 0.4 seconds is then categorized as closed eye. For the third closed eye with a time more than 0.4 seconds and less than 4 seconds then, it is categorized as drowsy eyes. However, if there is an open eye result, the time will be restarted after there is a description of the further closed eye detection results.

Position Detection

In GPS testing researchers places helmet in a certain location and then conducted studies looking at locations on websites. To observe the accuracy of the designation by sending Latittude and longitudes then is displayed to googlemaps. In this test, it will match the coordinates of the GPS module with the coordinates of the Smartphone Google Maps with latitude and longitude parameters. So, the difference between the two will be the benchmark of the accuracy of the sensor readings. The difference will be obtained as a result of calculating the difference in distance with the Euclidean Distance formula shown in equation 1.

$$d = \sqrt{(lat_1 - lat_2)^2 + (long_1 - long_2)^2}.(1\ derajat\ bumi) \quad (1)$$

Keterangan :
d : *Distance* / jarak
lat_1 : Latitude Google Maps
lat_2 : Latitude Modul GPS
$long_1$: Longitude Google Maps
$long_2$: Longitude Modul GPS
$1\ derajat\ bumi$: 111.322 Kilometer

Using kilometer units is to calculate how accurate the GPS ublox neo-6m module is, this test uses multiple location coordinate points.

Table 3. Module accuracy test result data GPS Ublox neo-6m

Location	Google Maps		GPS Module		Distance Different (km)
	latitude	Longitude	Latitude	longitude	
Alun-alun Jbr	-8.149760	113.721292	-8.149706	113.721230	0.000656382
Depan lab dasar	-8.150034	113.721007	-8.150023	113.721024	0.000179703
Pos gardu lab patrang	-8.149636	113.720385	-8.149675	113.720284	0.001066357
Tugu fakutas teknik	-8.162229	113.720847	-8.162226	113.720787	0.000633063
Kantor Pemkab jember	-8.169710	113.702073	-8.169702	113.702103	0.000316629
Average distance different					0.000349789

From the results of testing the accuracy of the GPS module *Ublox Neo-6m* with several experiments at locations or coordinate points is at the location around the Patrang Laboratory area, the location in the Jember University, Tegal Boto campus, and in front of the Jember Regency Government office. For the error limit in the test, the accuracy of the test will be set at 5 meters. This means that if in this test the error rate of each of these sensors exceeds 5 meters, it can be said that the sensor is said to be inaccurate, but the data above shows that in one of the locations, the Patrang laboratory preprint shows the results of the reading by google maps latitude -8.149333, longitude 113.720984 while the GPS module *Ublox neo-6m* latitude -8.149333, longitude 113.720978 with a difference in distance accuracy gets a value of 0.000063 km or 6.3 cm. Then for the next location is the Jember Regency Government office shows the results of reading by google maps with latitude -8.169710, longitude 113.702073 while the reading by GPS module *Ublox neo-6m* with latitude -8.169702, longitude 113.702103 with the difference in distance accuracy getting a value of 0.000316 km or 31.6 cm. There are several experimental point coordinates obtained as in Table 3 as well as the difference in the distance of each location between reading google maps and reading the GPS module.

Vibrating Motor

In the vibrating motor test, the researcher placed the vibrating motor in the helmet. The test was conducted when the eyes were closed ranging from 0.2 seconds to more than 0.4 seconds. This vibrating motor test aims to determine the condition of the rider when given a signal in the form of a vibrating motor if it is indicated that he is tired or sleepy. Vibration motor testing on eye conditions is shown in Figure 8. The test was carried out 8 times with variations of closed eyes. Table 4 is the data from the tests that have been carried out. Based on Table 4, it can be concluded that the vibrating motor will turn on (vibrate) when the eyes are detected to be closed for more than 0.4 seconds. Judging from the condition of the rider, it requires a minimum speed of 100 Rpm for a vibrating motor to be responded by the rider.

Figure 8. Vibrating Motor Testing on Eye Conditions

Table 4. Motor Condition on the Long Eyes Closed

The Long of Closed Eyes (Seconds)	Vibrating Motor Condition	Vibrating Motor Speed (Rpm)	The Rider Condition
0.2	Off	0	Conscious
0.4	Off	0	Conscious
0.5	On (Vibrate)	50	Unconscious
0.8	On (Vibrate)	50	Unconscious
0.8	On (Vibrate)	75	Unconscious
0.8	On (Vibrate)	100	Conscious
1.6	On (Vibrate)	100	Conscious
2.0	On (Vibrate)	100	Conscious

Conclusion

Helmet technology can be used as a technological advance in safety systems in the form of detecting closed and open eye conditions by using *the eye detection analysis method*. Based on the data, closed eye condition has a low mean RBG value between 110 to 113 and an RGB median value between 99 to 109. While the open eye condition has a higher value that is the RGB mean value between 179 to 206 and the median RGB value between 178 to 206. Fatigue or drowsiness in motorcycle riders can be seen by detecting the duration of closed eyes. It is said to be sleepy if the eyes are closed for more than 0.4 seconds. The information system in the form of a position using GPS which is placed on the rider's helmet as a form of emergency response in providing position information related to the occurrence of an accident with an average accuracy of 0.0003497 Km distance difference.

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